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EXAMINER	
HOFFBERG, ROBERT JOSEPH	

ART UNIT	PAPER NUMBER
2835	

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Please find below and/or attached an Office communication concerning this application or proceeding.

LC

Office Action Summary	Application No. 10/735,121	Applicant(s) MONGIA ET AL.
	Examin r Robert J. Hoffberg	Art Unit 2835

-- Th MAILING DATE of this communication app ars on th cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 May 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-24 and 27-31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-24 and 27-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12 December 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

Detailed Action

Response to Arguments

1. Applicant's arguments filed 5/15/06 have been fully considered but they are not persuasive.

2. Regarding applicant's argument with respect to motivation to combine adjusting the channel density of Goodson et al. with the particular channel arrangement of Chrysler et al. The examiner respectfully disagrees. Goodson et al. and Chrysler et al. are both in the field of the applicant's invention and pertinent to the particular problem with which the invention is concerned which is cooling of circuitry. MPEP 2141.01(a)(I). Goodson et al. discloses at Col. 15, lines 6-8 that "[t]he widths, depths and shapes of the channels 220 may also be adjusted to improve device temperature uniformity." Chrysler et al. discloses at Col. 3, lines 62-63 that "additional fins are located downstream to reduce the cross section of area in the path flow." Chrysler et al. further teaches at Col. 3, lines 57-59 that "[t]his construction decreases the cross section of area in path of flow and thereby increases the coolant velocity". Chrysler et al. continues to disclose at Col. 3, lines 49-50 that [t]his increase in velocity improves the heat transfer." Both references provide suggestions in the prior art regarding changing the widths of the channels to improve the heat dissipation properties. Goodson et al. teaches in general, to vary the channel sizes, but lacks the specific structure as claimed. Chrysler et al. teaches a specific structure as claimed by applicant of varying the channel sizes by having areas of different channel widths. The suggestion or

motivation to combine, in this case, is within both prior art references which is to vary the channel size to maximize the cooling of the integrated circuit chip.

3. Regarding applicant's argument about Chrysler teaching away from the combination. The examiner respectfully disagrees. The applicant defines integrated circuit chip 110 as an element that "may include circuitry, such as transistors, that produces heat to be removed from device 100. The top portion of integrated circuit chip 110 illustrated in FIG. 1 may include silicon (Si), germanium (Ge), or another structural or packaging material typically used in integrated circuits. In some implementations consistent with the principles of the invention, integrated circuit chip 110 may include a microprocessor, digital signal processor, graphics processor, or the like that consumes a significant amount of power (e.g., tens to hundreds of watts) and generates a corresponding amount of heat." Applicant broadly defines integrated circuit chip as having circuitry that consumes a significant amount of power and generates a corresponding amount of heat. Goodson et al. teaches at Col. 1, line 14 removal of heat from an integrated circuit and further discloses at Col 12, lines 63-65, a device that may have "multiple chips into a single device 50 package". The examiner interprets the applicant's integrated circuit chip as containing one or more chips within a single device. The Chrysler et al. reference is being used to teach a specific channel arrangement and is pertinent as analogous art because it discloses the problem that that the applicant is concerned with. The proposed modification to Goodson et al. with specific channel arrangement of Chrysler's does not in any way prevent Goodson et al. from cooling the circuitry. The combined teachings of Goodson et al. with that of Chrysler et al. suggests

to one of ordinary skill in the art a specific channel arrangement to cool an integrated circuit chip where the circuitry dissipates heat unevenly.

4. Regarding applicant's arguments concerning motivation to combine Tuckerman et al in the rejection to Claim 19. The examiner respectfully disagrees. The motivation to combine may be common knowledge in the art. As an example of the common knowledge in the art is Lee (US 6,6,98,502) which teaches at Col. 1, lines 12-15 that "heat generated by an integrated circuit device ... tend to be degenerated in product reliability." Integrating the microchannels within the device rather than as a separate component coupled to the integrated circuit device reduces the component count.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1-13, 15 and 27-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goodson et al. (US 6,942,018) in view of Chrysler et al. (US 4,765,397).

With respect to claim 1, Goodson et al. teaches a device, comprising: an integrated circuit chip (Fig. 1, #50); and enclosed channels (Fig. 3A, #220-1 and #220-2) to carry a liquid coolant (Col. 11, line 59) that are proximate to a surface (Fig. 3B, #50 top) of the integrated circuit chip and that extend along a length (see Fig. 3A) of the integrated circuit chip. While Goodson teaches that the channel densities may change

(Col. 15, lines 6-7), it fails to teach of the abrupt density change. Chrysler et al. teaches wherein a density of the channels (Fig. 5, #61 and 62) changes abruptly at least once across the length of the integrated circuit chip or across a width of the integrated circuit chip. With respect to claim 6, Chrysler et al. further teaches the channels include: a first area (Fig. 5, #62) having a first channel density, and a second area (Fig. 5, #61) adjacent to the first area and having a second channel density that is lower than the first channel density. With respect to Claim 7, Chrysler et al. further teaches at least one of the first and second areas span a full width (Fig. 5, from area near #54 to area near #56) of the integrated circuit chip (Col. 1, line 20). With respect to claim 8, Chrysler et al. further teaches the channels further include: a third area (Fig. 5, #60) adjacent to the second area (Fig. 5, #61) having a third channel density that is different than the second channel density.

With respect to Claim 2, Goodson et al. further teaches the channels are formed in the integrated circuit chip and substantially under the surface (Fig. 3B, under top surface of #214) of the integrated circuit chip.

With respect to Claim 3, Goodson et al. further teaches that a heat exchange layer (Fig. 3B, #210) over the integrated circuit chip, wherein the channels are formed in (see Fig. 3B) the heat exchange layer.

With respect to Claim 4, Goodson et al. further teaches a cap (Fig. 3B, #214) on the heat exchange layer to at least partially define the channels (Fig. 3B, #220C).

With respect to Claim 5, Goodson et al. further teaches an interface layer (Col. 13, line 48) between the integrated circuit chip and the heat exchange layer.

With respect to Claim 9, Chrysler et al. further teaches wherein the channels (Fig. 5, #61 and #62) are longitudinally offset (see Fig. 5) at least once within the first area.

With respect to claim 10, Goodson et al. teaches a device, comprising: a semiconductor base (Fig. 1, #50) including an area of higher power density and an area of lower power density (Col. 15, lines 6-7); and a heat exchange layer (Fig. 3B, #200) over the semiconductor base and including enclosed channels (Fig. 3A, #220A and #220B) formed therein suitable for carrying liquid coolant (Col. 11, line 59). While Goodson teaches that the channel dimensions may vary, it fails to teach different channel densities. Chrysler et al. teaches wherein a density of the channels (Fig. 5, #62) over the area of higher power density is higher than a density of the channels (Fig. 5, #61) over the area of lower power density.

With respect to claim 11, Goodson et al. further teaches a thermal interface layer (Col. 13, line 48) between the semiconductor base and the heat exchange layer.

With respect to claim 12, Goodson et al. further teaches a plate (Fig. 3B, #214) on the heat exchange layer to at least partially define the channels (Fig. 3B, #220C).

With respect to Claim 13, Goodson et al. in view of Chrysler et al. teaches the device in Claim 10. They discloses the claimed invention except for a density ratio of the channels or arteries. It would have been obvious to one having ordinary skill in the art at the time the invention was made to include a density ratio of greater than 1.1 or any ratio which would allow the device or system to operate at increased efficiency, since it has been held that where the general conditions of a claim are disclosed in the

prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

With respect to claim 15, while Goodson teaches a semiconductor with different power densities (Col. 15, lines 6-7) and varying channel dimensions (Col. 11, lines 11-12) including the internal fins (Col. 11, line 20) according to the power densities, it fails to define a semiconductor with a lower, intermediate and higher power densities. Chrysler et al. further teaches a lower (Fig. 5, #60), intermediate (Fig. 5, #61) and higher (Fig. 5, #62) channel densities.

With respect to claim 27, Goodson et al. teaches a method, comprising: forming first channels (Fig. 4, #220A-1 thru #220A-6) in a layer (Fig. 3B, #210) of a semiconductor device (Fig. 3B, #50); forming second channels (Fig. 4, #220A-7 thru #220A-11) in the layer of a semiconductor device adjacent to the first channels and in a same direction (see Fig. 4) as the first channels and capping (Fig. 3B, #214) the first and second channels to form a channel structure suitable for carrying liquid coolant (Col. 11, line 59) through the semiconductor device. Goodson et al. fails to teach varying the width of the channels. Chrysler et al. teaches that the second channels (Fig. 5, #61) having a greater average width than the first channels (Fig. 5, #62).

With respect to claim 28, Goodson et al. further teaches wherein the layer of the semiconductor device includes copper, aluminum, or silicon (Col. 6, lines 55-56).

With regard to Claim 29, Goodson et al. teaches a device, comprising: an integrated circuit chip (Fig. 3B, #50); and channels (Fig. 4, #220A-1 thru #220A-11) to carry a coolant (Col. 11, line 59) that are proximate (See Fig. 3B) to a surface of the

integrated circuit chip and that extend along a length (see Fig. 4) of the integrated circuit chip. Goodson et al. fails to teach longitudinal channel offset. Chrysler et al. teaches wherein the channels (Fig. 5, #61 and #62) are longitudinally offset at least once (see Fig. 5) along the length. With respect to Claim 30, Chrysler et al. further teaches wherein the channels (Fig. 5, #60, #61 and #62) are longitudinally offset at least twice (see Fig. 5) along the length of the integrated circuit chip.

With respect to Claim 31, Goodson et al. further teaches wherein the channels have a substantially uniform density (see Fig. 4) along the length of the integrated circuit chip.

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Goodson et al. with that of Chrysler et al. for the purpose of changing the channel density by varying the channel width, thereby changing the cross section and flow resistance, in proportion to cooling needs of integrated circuit chip to maximize heat dissipation according to the cooling needs integrated circuit chip.

7. Claims 14 and 19-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goodson et al. (US 6,942,018) in view of Chrysler et al. (US 4,765,397) as applied to the above claims, and further in view of Tuckerman et al. (US 4,450,472).

With respect to Claim 14, Goodson et al. in view of Chrysler et al. teaches the device in Claim 10. They fail to teach wherein the channels over the area of higher power density include at least two staggered segments. Tuckerman et al. teaches

wherein the channels (Fig. 4, between #36) over the area of higher power density (Fig. 5, #40) include at least two staggered segments (Fig. 4, discontinuity of #36).

With respect to Claim 19, Goodson et al. teaches a device, comprising: an integrated circuit chip (Fig. 1, #50) including and a heat exchanger with channels (Fig. 3A, #220-1 and #220-2) in a surface (Fig. 3B, #210 top) thereof; and a cap (Fig. 3B, #214) connected to the integrated circuit chip to define a top of the channels. While Goodson et al. teaches the width of the channels changes (see Fig. 3A), it fails to teach that an average width of the channels substantially changes at least once along a length of the channels. Goodson et al. also fails to teach the channels in a surface of the chip. Chrysler et al. teaches that an average width of the channels substantially changes (Fig. 5, #61 and #62) at least once along a length of the channels. Tuckerman et al. teaches an integrated circuit chip (Fig. 1, #10) including with channels (Fig. 1, #14) in a surface (Col. 2, lines 36-37) thereof.

With respect to Claim 20, Goodson et al. in view of Chrysler et al. further in view of Tuckerman et al. teaches the device in Claim 19. They fail to teach a ratio of the average width of the channels. While Goodson et al. in view of Wang fails to disclose the specific ratio, it is obvious that a ratio of higher average width to lower average width channels exists as seen in Chrysler et al., Fig. 5. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to include an average width ratio of less than 8 or any ratio which would allow the device to operate at maximum efficiency.

With respect to Claim 21, Chrysler et al. further teaches the channels (Fig. 5, #50 described in description as #60) within the area of lower average width include at least one discontinuity (Col. 6, line 48-49).

With respect to Claim 22, Chrysler et al. further teaches wherein an average width of the channels (Fig. 5, #60, 61 and 62) substantially changes at least twice (see Fig. 5) along a length of the channels.

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Goodson et al. with that of Chrysler et al. further in view of Tuckerman et al. for the purpose of interrupting the longitudinal fins for to improving air flow and changing the channel density including channel width in proportion to cooling needs of integrated circuit chip and incorporating the cooling channels within the integrated circuit chip to improve the reliability of the system, reduce component count and to maximize heat dissipation.

8. Claims 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goodson et al. (US 6,942,018) in view of Chrysler et al. (US 4,765,397) as applied to the claim 10 above, and further in view of Crowe (US 4,944,344).

With respect to claim 16, Goodson et al. in view of Chrysler et al. teaches the device in Claim 10. They do not teach a second heat exchange layer over another heat exchange layer. Crowe teaches an upper heat exchange layer (Fig. 1C, #25) over the heat exchange layer (Fig. 1C, #12) and including upper channels (Fig. 1C, #25) formed therein suitable for carrying liquid coolant.

With respect to claim 17, Goodson et al. in view of Chrysler et al. further in view of Crowe teach the device in Claim 16. They do not teach that the density the channels vary over different power densities. Goodson et al. further teaches that the channel geometry (Col. 15, lines 6-7) can vary according to the power density. Chrysler et al. further teaches that a density of the channels (Fig. 5, #61 and #62) can vary.

With respect to claim 18, Goodson et al. in view of Chrysler et al. further in view of Crowe teach the device in Claim 16. They do not teach that the channels in different layers are orthogonal to each other. Crowe teaches in another embodiment wherein a direction of the channels (Fig. 1, #11 and #12) in the heat exchange layer (Fig. 1, upper layer) is substantially orthogonal to a direction of the upper channels (Fig. 1, #18) in the upper heat exchange layer (Fig. 1, lower layer).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Goodson et al. Chrysler et al. with that of Crowe to add additional heat exchange layers, to vary the density of the channels in each of the heat exchange layers according to the different power densities and provide layers with channels in a different axis to maximize uniformity of cooling.

9. Claims 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goodson et al. (US 6,942,018), in view of Chrysler et al. (US 4,765,397), further in view of Tuckerman et al. (US 4,450,472) as applied to the above claims, and further in view of Crowe (US 4,944,344).

With respect to claim 23, Goodson et al. in view of Chrysler et al. further in view of Tuckerman et al. teaches the device in the above claims. They fail to teach a second

heat exchange layer. Crowe teaches a heat exchange layer (Fig. 1C, left layer) over the cap (Fig. 1C, #14) and including upper channels (Fig. 1C, #25) formed therein suitable for carrying liquid coolant (Col. 3, line 35). Chrysler et al. further teaches average width of the upper channels (Fig. 5, #61 and #62) substantially changes at least once (see Fig. 5) along a length of the upper channels.

With respect to claim 24, Crowe further teaches in another embodiment wherein a direction of the channels (Fig. 1, #11 and #12) in the heat exchange layer (Fig. 1, upper layer) is substantially orthogonal to a direction of the upper channels (Fig. 1, #18) in the upper heat exchange layer (Fig. 1, lower layer).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the device of Goodson et al., in view of Chrysler et al., further in view of Tuckerman et al. with that of Crowe to add a second heat exchange layer with varying average channel widths and to provide layers with channels in a different axis to maximize the heat dissipation and improve uniformity of cooling.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Suzuki (US 6,466,441) teaches a first set of channels substantially orthogonal to a second of channels.

11. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Robert J. Hoffberg whose telephone number is (571) 272-2761. The examiner can normally be reached on 8:30 AM - 4:30 PM Mon - Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynn D. Feild can be reached on (571) 272-2092. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

RJH

MICHAEL DATSKOVSKIY
PRIMARY EXAMINER

06/02/06